Remarks

Claims 1-34 are pending. Claim 34 is newly added. It presents claim 1 using alternative wording which keeps more closely to the terminology originally used upon filing. Claims 1-4 & 6-32 are rejected. Claims 5 and 32 are objected to. Reexamination and reconsideration are requested.

The subheadings below conform to those used in the Office Action to which this document responds.

Claim Rejections - 35 U.S.C. § 112

Claims 8-10 & 18-32 stand rejected under 35 U.S.C. § 112 ¶ 2 as being indefinite.

The reference in claims 8, 10, 18 and 20 to "the larger of the input disc and out disc" is intended to cover the situation where the input disc and the output disc are of different sizes. Claims 8 & 18 have been amended for clarity. Dependent claims 9-10 & 19-32 include the limitations of claims 8 & 18 and now pass muster under 35 U.S.C. § 112 ¶ 2.

Claim Rejections - 35 U.S.C. § 102

Claims 1, 2, 6-15, 17-25 & 27 are rejected under 35 U.S.C. § 102(b) as being anticipated by Imanishi (JP 7-280055).

The claimed invention and Imanishi (JP 7-280055) operate in fundamentally different ways from one another. In very general terms, the transmission disclosed in Imanishi is a so-called "ratio-controlled" transmission. The transmission of the present application is a so-called "torque-controlled" transmission.

In a ratio-controlled transmission, the effective ratio of the transmission is controlled by choosing the inclination of the rotational axes of the rollers which are in contact with the input and output discs. In other words, the effective ratio of the transmission is specified and the inclination of the rotational axes of the rollers is adjusted accordingly. The effective ratio of the transmission is incompletely independent of the torque on the input and output discs of the transmission and would remain at the specified angle of inclination unless and until a new inclination is specified.

This operation is clearly shown in Imanishi (see, for example, numbered paragraphs [0031] to [0036]). In order to assist the Examiner, we attach a computer-generated translation of the Imanishi reference.

In contrast, in the torque-controlled transmission of the present invention, the inclination of the rollers is not specified directly. The rollers are each mounted on a roller carriage and a reaction force is applied to the roller carriage via a pivoting joint (for example the universal joint or Rose bearing 47). The roller carriage is therefore free to rotate with respect to the actuator lever.

The angle of inclination of the rotational axes of the rollers is therefore a function of the torque on the input and output discs, with which the rollers are in rolling contact, and of the reaction torque applied to the roller carriage. Thus, in contrast to ratio controlled variators, in a torque-controlled variator, the inclination of the rotational axes of the rollers (and therefore the effective ratio of the transmission) is not specified, but is instead a function of the applied torques on the input and output discs and the reaction force applied to the roller carriage. Consequently, the inclination of the rollers (and therefore the effective ratio of the variator) can change if the torque on the input disc or output disc or the reaction torque changes.

In order to emphasize the differences between the claimed invention and the arrangements disclosed in Imanishi, it is proposed to amend claims 1 & 18 to make it clear that

each roller is mounted on a roller carriage (item 34) and that each roller carriage has a pivoting joint, the actuators acting upon the pivoting joint on each roller carriage via one of the levers.

In light of these amendments, the invention as defined by the independent claims 1 & 18 can not be said to be anticipated by Imanishi. Dependent claims 2-17 & 19-32 include the limitations respectively of claims 1 & 18 and can not be said to be anticipated by Imanishi.

As noted above, newly offered claim 34 resembles claim 1, but adopts terminology that more closely resembles that which was originally filed. For these reasons, claim 34 is not anticipated by Imanishi.

Claim Rejections - 35 U.S.C. § 103

Claims 3-4 & 28-31 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Imanishi (JP 7-280055). For the reasons stated earlier, the invention as defined by these claims can not be said to be obvious in light of Imanishi, as the latter teaches away from the claimed invention.

For these reasons, claims 3-4 & 28-31 can not be said to be anticipated by Imanishi.

Claims 16 & 26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Imanishi (JP 7-280055) in view of Yamamoto (US 5,971,886).

The Examiner concedes that Imanishi does not disclose the cylinders disposed in a common cylinder block. The invention as defined by claim 16 includes the limitations of claims 13 & 1, which differ from Imanishi for the reasons expressed earlier. No contribution of Yamamoto will render obvious the invention as defined in claim 16 for the reasons set forth earlier.

For similar reasons, the invention as defined by claim 26 is non-obvious because it includes the limitations of claims 23 & 18. The earlier discussion is incorporated herein by reference and for brevity not repeated here.

Allowable Subject Matter

Claim 5 is objected to as being dependent the rejected base claim. Claim 5 now is rewritten and incorporates the limitations of claims 4, 3 & 1.

Claim 32 also is said to be allowed when rewritten. Claim 32 includes the limitations of claims 18 & 28. Claim 32 has been rewritten in order to overcome the rejections under 35 U.S.C. § 112 ¶ 2.

All formal and substantive requirements for patentability appear now to have been met. A Notice of Allowance is earnestly solicited.

Please charge any fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978.

Respectfully submitted,

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CLAIMS

[Claim(s)]
[Claim 1]In a toroidal type nonstep variable speed gear characterized by comprising the following, the center of a pivot of at least one trunnion, A toroidal type nonstep variable speed gear, wherein the ends of a pivot and a driving rod in which whose center of a driving rod driven with an actuator attached to this trunnion is inharmonious, and these centers do not correspond mutually are combined by a displacement means of communication.
the state where mutual medial surfaces were made to counter -- mutual -- the same mind -- and the first supported enabling free rotation and the second disk.
A support member provided in a position which sandwiches the second disk for a start [these].
Two or more trunnions which have a pivot in a position twisted to a medial axis of the second disk for a start [said] that it should support pivotably in this support member, and rock this pivot as a center.

A power roller pinched between both the second disk for a start [said] in the state where it was supported around an actuator which is attached to each trunnion and displaces these each trunnion to shaft orientations of the above-mentioned pivot, a displacement shaft projected from a medial surface of each of said trunnion, and this displacement shaft enabling free rotation.

[Detailed Description of the Invention]

[0001]

[Industrial Application]The toroidal type nonstep variable speed gear concerning this invention is used as a gearbox for various industrial machines, for example as a gearbox for cars, respectively.

[0002]

[Description of the Prior Art]Using a toroidal type nonstep variable speed gear which ****s in drawing 5 - 6 as a gearbox for cars is studied. This toroidal type nonstep variable speed gear supports the input side disk 2 to the input shaft 1 and the same mind, and is fixing the output side disc 4 to the end of this input shaft 1 and the output shaft 3 arranged at the same mind as indicated by JP,62-71465,U, for example. Inside the casing which dedicated the toroidal type nonstep variable speed gear, the trunnions 6 and 6 which rock as a center the pivots 5 and 5 which are in the position of torsion to said input shaft 1 and the output shaft 3 are formed.

[0003]Each trunnions 6 and 6 have formed said pivots 5 and 5 in the both-ends lateral surface. In the central part of each trunnions 6 and 6, the base end of the displacement shafts 7 and 7 is supported, and regulation of the angle of gradient of each displacement shafts 7 and 7 is enabled by making each trunnions 6 and 6 rock focusing on said pivots 5 and 5. Around the displacement shafts 7 and 7 supported by each trunnions 6 and 6, the power rollers 8 and 8 are supported, respectively, enabling free rotation. And each power rollers 8 and 8 are pinched between said input side and output side both the disks 2 and 4.

[0004]The concave surface acquired by the medial surfaces 2a and 4a where input-side and output side both the disks 2 and 4 counter mutually making rotate the circle [section] centering on the above-mentioned pivot 5, respectively is made. And the peripheral surfaces 8a and 8a of each power rollers 8 and 8 formed in the spherical convex are made to contact said medial surfaces 2a and 4a.

[0005]The loading cam-type pressing device 9 is formed between said input shaft 1 and the input side disk 2, and with this

pressing device 9, said input side disk 2 is turned to the output side disc 4, and is pressed elastically. This pressing device 9 comprises the cam board 10 which rotates with the input shaft 1, and the cam rollers [two or more (for example, four pieces)] 12 and 12 retained by the cam roller cage 11. The cam surface 13 which is a rugged surface covering a circumferencial direction is formed in the one side (drawing 5 - six left laterals) of said cam board 10, and the same cam surface 14 is formed also in the lateral surface (drawing 5 - six right laterals) of said input side disk 2. And said two or more rollers 12 and 12 are supported to the center of said input shaft 1, enabling free rotation centering on the axis of a radial direction.

[0006]If the cam board 10 rotates with rotation of the input shaft 1 at the time of use of the toroidal type nonstep variable speed gear constituted as mentioned above, two or more rollers 12 and 12 will be pressed by the cam surface 13 in the cam surface 14 of input side disk 2 lateral surface. As a result, based on engagement with said one pair of cam surfaces 13 and 14, and two or more rollers 12 and 12, said input side disk 2 rotates at the same time said input side disk 2 is pressed by said two or more power rollers 8 and 8. And rotation of this input side disk 2 is transmitted to the output side disc 4 via said two or more power rollers 8 and 8, and the fixed output shaft 3 rotates to this output side disc 4.

[0007]By the case where the revolving speed of the input shaft 1 and the output shaft 3 is changed, in slowing down between the input shaft 1 and the output shaft 3 first, Each trunnions 6 and 6 are made to rock focusing on the pivots 5 and 5, and each displacement shafts 7 and 7 are made to incline so that the main slippage portion of the medial surface 2a of the input side disk 2 and the periphery slippage portion of the medial surface 4a of the output side disc 4 may be contacted, respectively as the peripheral surfaces 8a and 8a of each power rollers 8 and 8 show drawing 5.

[0008]When accelerating, said trunnions 6 and 6 are made to rock on the contrary, Each displacement shafts 7 and 7 are made to incline so that the periphery slippage portion of the medial surface 2a of the input side disk 2 and the main slippage portion of the medial surface 4a of the output side disc 4 may be contacted, respectively as the peripheral surfaces 8a and 8a of each power rollers 8 and 8 show drawing 6. If the angle of gradient of each displacement shafts 7 and 7 is carried out in the middle of drawing 5 and drawing 6, a middle change gear ratio can be obtained between the input shaft 1 and the output shaft 3.

[0009]Drawing 7 - 8 show the toroidal type nonstep variable speed

gear which was indicated on the microfilm of the application for utility model registration No. (JP,1-173552,U) 69293 [Showa 63 to] and which was materialized more. Around the tube-like input shaft 15, the input side disk 2 and the output side disc 4 are supported via the needle bearings 16 and 16, respectively, enabling free rotation. Spline engagement of the cam board 10 is carried out to the end (left edge part of drawing 7) peripheral face of said input shaft 15, and movement in the direction which separates from said input side disk 2 by the flange 17 is prevented. And the loading cam-type pressing device 9 rotated turning said input side disk 2 to the output side disc 4, and pressing it with these cam board 10 and rollers 12 and 12 based on rotation of said input shaft 15 is constituted. The output-tooth vehicle 18 is combined by the keys 19 and 19, these output side discs 4 and the output-tooth vehicle 18 synchronize with said output side disc 4, and he is trying to rotate.

[0010]Each is supporting the both ends of the trunnions 6 and 6 whose number is one to one pair of support plates 20 and 20 which are support members, enabling rocking and the free displacement covering shaft orientations (the direction of a rear surface of drawing 7, the longitudinal direction of drawing 8). And the displacement shafts 7 and 7 are supported into the circular hole 23 and 23 portions which were formed in the pars intermedia of each of said trunnions 6 and 6. Each displacement shafts 7 and 7 are mutually parallel, and have the supporting spindle parts 21 and 21 and the supporting shaft parts 22 and 22 which carried out eccentricity, respectively. Each supporting spindle parts 21 and 21 of these are supported via the radial needle bearings 24 and 24 inside said each circular holes 23 and 23, enabling free rotation. The power rollers 8 and 8 are supported via the radial needle bearings 25 and 25 around said each supporting shaft parts 22 and 22, enabling free rotation.

[0011]Said one pair of displacement shafts 7 and 7 are formed in the opposite side position 180 degrees to said input shaft 15. Each supporting shaft parts 22 and 22 of these each displacement shafts 7 and 7 make the direction which is carrying out eccentricity to each supporting spindle parts 21 and 21 the direction (it is a right-and-left opposite direction at drawing 8) about the hand of cut of said input side and output side both the disks 2 and 4. The eccentric direction is made into the direction which intersects perpendicularly mostly to the arranging direction of said input shaft 15. Therefore, said each power rollers 8 and 8 are supported, enabling free displacement of some covering the arranging direction of said input shaft 15. As a result, this displacement can be absorbed, without applying power with each

part article of composition impossible for, even when it becomes the tendency to originate in the dimensional accuracy of component parts, etc. and for said each power rollers 8 and 8 to be displaced to the shaft orientations of said input shaft 15.

[0012]Between the lateral surface of each of said power rollers 8 and 8, and the pars intermedia medial surface of each of said trunnions 6 and 6, the thrust ball bearings 26 and 26 and the thrust needle bearings 27 and 27 are formed sequentially from the lateral-surface side of the power rollers 8 and 8. The thrust ball bearings 26 and 26 of these permit rotation of these each power rollers 8 and 8, supporting movably the load of the thrust direction added to said each power rollers 8 and 8. Such thrust ball bearings 26 and 26 comprise the circular cages 28 and 28 which hold the balls 29 and 29 and each balls 29 and 29 of every plurality, respectively enabling free rolling, and the circular outer rings of spiral wound gasket 30 and 30. The inner race track of each thrust ball bearings 26 and 26 is formed in the lateral surface of each of said power rollers 8 and 8, and the outer race track is formed in the medial surface of each of said outer rings of spiral wound gasket 30 and 30, respectively.

[0013]Said thrust needle bearings 27 and 27 comprise the race 31, the cage 32, and the needles 33 and 33. The race 31 and the cage 32 of these are put together, enabling free displacement of some covering a hand of cut.Such thrust needle bearings 27 and 27 are in the state where said races 31 and 31 were made to contact the medial surface of each of said trunnions 6 and 6, and are pinched between this medial surface and the lateral surface of said outer rings of spiral wound gasket 30 and 30. Such thrust needle bearings 27 and 27 permit that said supporting shaft parts 22 and 22 and said outer rings of spiral wound gasket 30 and 30 rock said supporting spindle parts 21 and 21 as a center, supporting movably thrust loading added to said each outer rings of spiral wound gasket 30 and 30 from said each power rollers 8 and 8.

[0014]The driving rods 36 and 36 are combined with the end part (left edge part of drawing 8) of each of said trunnions 6 and 6, respectively, and the driving pistons 37 and 37 are fixed to the pars intermedia peripheral face of each driving rods 36 and 36. And these each driving pistons 37 and 37 are fitted in an oiltight in the oil hydraulic cylinder 38 and 38 for a drive, respectively. The oil hydraulic cylinders 38 and 38 which fitted in these each driving pistons 37 and 37 constitute the actuator for displacing said each trunnions 6 and 6.

[0015]In the case of the toroidal type nonstep variable speed gear constituted as mentioned above, rotation of the input shaft 15 is told to the input side disk 2 via the pressing device 9. And

rotation of this input side disk 2 is told to the output side disc 4 via one pair of power rollers 8 and 8, and rotation of this output side disc 4 is further taken out from the output-tooth vehicle 18.

[0016]In changing the revolving speed ratio between the input shaft 15 and the output-tooth vehicle 18, it displaces mutually said one pair of driving pistons 37 and 37 to an opposite direction. Said one pair of trunnions 6 and 6 are displaced to an opposite direction with displacement of these each driving pistons 37 and 37, respectively, for example, the power roller 8 of the drawing 8 bottom is displaced, and the power roller 8 of the figure upper part is displaced on the left-hand side of the figure on the right-hand side of the figure, respectively. As a result, the direction of the power of a tangential direction which acts on a contact part with the medial surfaces 2a and 4a of the peripheral surfaces 8a and 8a of these each power rollers 8 and 8, said input side disk 2, and the output side disc 4 changes. And said each trunnions 6 and 6 rock to an opposite direction mutually focusing on the pivots 5 and 5 supported pivotably by the support plates 20 and 20 with change of direction of this power. As a result, as shown in above-mentioned drawing 5 - 6, the contact position of the peripheral surfaces 8a and 8a of each of said power rollers 8 and 8 and each of said medial surfaces 2a and 4a changes, and the revolving speed ratio between said input shaft 15 and the output-tooth vehicle 18 changes.

[0017]Thus, if the angle of gradient of said displacement shafts 7 and 7 is changed in order to change the revolving speed ratio between said input shaft 15 and the output-tooth vehicle 18, these each displacement shafts 7 and 7 will rotate slightly said each supporting spindle parts 21 and 21 as a center. The lateral surface of the outer rings of spiral wound gasket 30 and 30 of each of said thrust ball bearings 26 and 26 and the medial surface of each of said trunnions 6 and 6 carry out a relative displacement as a result of this rotation. Since said each thrust needle bearings 27 and 27 exist between these lateral surface and a medial surface, the power which this relative displacement takes is small. Therefore, the power for changing the angle of gradient of each displacement shafts 7 and 7 as mentioned above is small, and ends.

[0018]When making rotational movement transmit to the output side disc 4 from said input side disk 2, thrust loading covering the shaft orientations of each of said pivots 5 and 5 is added to said each trunnions 6 and 6 via said each power rollers 8 and 8. Thus, added thrust loading is supported movably by said oil hydraulic cylinders 38 and 38. Cover the shaft orientations of the pivots 5

and 5, and displace the trunnions 6 and 6, and. The structure of forming the oil hydraulic cylinders 38 and 38 for supporting movably thrust loading added to these trunnions 6 and 6 in the both sides of each trunnions 6 and 6 is also known from the former as indicated, for example to JP,62-199562,U.

[0019]In order to enlarge power which can be transmitted with a toroidal type nonstep variable speed gear, increasing the number of the power rollers 8 and 8 is also considered from the former. For example, in JP,3-74667,A, the structure which formed the three power rollers 8 and 8 in the hand of cut at equal intervals for the input side disk 2 and the output side disc 4 is indicated. In the case of the structure indicated in this gazette, as shown in drawing 9, each supports pivotably the pars intermedia of the holding pieces 59 and 59 which are the support members bent at 120 degrees at the three-place position of the circumferencial direction regular intervals of the fixed frame 58. And the trunnions 6 and 6 are supported between the adjacent holding piece 59 and 59 comrades, respectively, enabling rocking and the free displacement covering shaft orientations.

[0020]One end of the driving rods 36 and 36 is connected with the end part of each of said trunnions 6 and 6, and the other end of these each driving rods 36 and 36 is connected with the driving pistons 37 and 37 of the oil hydraulic cylinders 38 and 38 which are actuators. These each oil hydraulic cylinders 38 and 38 lead to the delivery of the pump 63 which is a hydraulic power unit via the control valve 62 which each covered shaft orientations (longitudinal direction of drawing 9), and was provided with the sleeve 60 which can be displaced freely, and the spool 61.

[0021]When each changes the angle of gradient of the power rollers 8 and 8 supported pivotably by said each trunnions 6 and 6 by the displacement shafts 7 and 7, said sleeve 60 is displaced to shaft orientations (longitudinal direction of drawing 9) with the controlling motor 64. As a result, the pressure oil breathed out from said pump 63 is sent into said each oil hydraulic cylinders 38 and 38 through a hydraulic line. As a result, the driving pistons 37 and 37 fitted in these each oil hydraulic cylinders 38 and 38 are displaced in the direction about the hand of cut of the input side disk 2 and the output side disc 4 (drawing 5 - seven references). The hydraulic oil extruded from said each oil hydraulic cylinders 38 and 38 with displacement of each of said driving pistons 37 and 37 is returned to the sump 65 through the hydraulic line which contains said control valve 62 too.

[0022]On the other hand, displacement of the driving piston 37 accompanying sending of said pressure oil is transmitted to said spool 61 via the cam 66 and the link 67, and displaces this spool

61 to shaft orientations. As a result, after said driving piston 37 has carried out specified quantity displacement, the channel of said control valve 62 is closed and the feeding and discarding of the pressure oil to said each oil hydraulic cylinders 38 and 38 are suspended. Therefore, the amount of displacement and **** covering the shaft orientations of each of said trunnions 6 and 6 become a thing according to the amount of displacement of the sleeve 60 according [the angle of gradient of each of said power rollers 8 and 8] to said controlling motor 64.

[0023]

[Problem(s) to be Solved by the Invention]However, when it was the conventional toroidal type nonstep variable speed gear which is constituted as mentioned above and acts, it was difficult to attain not necessarily sufficient small weight saving. That is, in the case of structure, all arranged the pivots 5 and 5 of two or more trunnions 6 and 6, and the oil hydraulic cylinder 38 for displacing these trunnions 6 and 6 to shaft orientations and the driving rods 36 and 36 of the actuator of 38 grades to the same mind conventionally which was mentioned above. For this reason, according to the number of said trunnions 6 and 6, the installed position of these each oil hydraulic cylinders 38 and 38 was limited, and it had become a cause which a device enlarges.

[0024]To use a toroidal type nonstep variable speed gear, for example as a gearbox for cars, it is necessary to install in the limited space, such as an under floor of a car, and an engine room, and to miniaturize. Such a problem becomes remarkable when the number of the power rollers 8 and 8 is increased, as shown in said JP,3-74667,A.

[0025]For example, in the case of the structure indicated in this gazette, the ring part 68 is formed in the middle of some driving rods 36, and these each driving rod 36 and 36 comrades are prevented from interfering by inserting other driving rods 36 in this ring part 68. It is not avoided that such a structure causes a manufacturing cost jump by complicated-izing of part processing and assembly operation. The toroidal type nonstep variable speed gear of this invention is invented in view of such a situation.

[0026]

[Means for Solving the Problem]A toroidal type nonstep variable speed gear of this invention in the state where mutual medial surfaces were made to counter, like the conventional toroidal type nonstep variable speed gear mentioned above. To the same mind, mutually And the first and the second disk which were supported enabling free rotation, Two or more trunnions which have a pivot in a position twisted to a medial axis of the second disk for a start [said] that it should support pivotably for a start [

these] in a support member provided in a position which sandwiches the second disk, and this support member, and rock this pivot as a center, In the state where it was supported around an actuator which is attached to each trunnion and displaces these each trunnion to shaft orientations of the above-mentioned pivot, a displacement shaft projected from a medial surface of each of said trunnion, and this displacement shaft enabling free rotation. It has a power roller pinched between both the second disk for a start [said].

[0027]Especially in a toroidal type nonstep variable speed gear of this invention, The center of a pivot of at least one trunnion and the center of a driving rod driven with an actuator attached to this trunnion are inharmonious, and the ends of a pivot and a driving rod in which these centers do not correspond mutually are combined by a displacement means of communication.

[0028]

[Function]The toroidal type nonstep variable speed gear of this invention constituted as mentioned above is transmitting torque between the first disk and the second disk, and also changing the angle of gradient of a trunnion based on the same operation as the conventional toroidal type nonstep variable speed gear mentioned above, and changes the revolving speed ratio of these both disks.

[0029]In particular, in the case of the toroidal type nonstep variable speed gear of this invention, the flexibility of the installed position of the actuator for covering the shaft orientations of a pivot and displacing two or more trunnions increases. Therefore, the small weight saving of a toroidal type nonstep variable speed gear can be attained by efficient arrangement of the actuator of these plurality.

[0030]

[Example]Drawing 1 shows what applied this invention to the structure which formed the two power rollers 8 and 8 in the circumferencial direction as the first example of this invention. The feature of this invention has the feature in the structure of the oil hydraulic cylinder 38 which displaces one pair of trunnions 6 and 6 which supported said two power rollers 8 and 8 pivotably to shaft orientations (longitudinal direction of drawing 1), and the portion which enables efficient arrangement of the actuator of 38 grades. The structure of other portions and an operation are the same as that of structure conventionally which was shown in above-mentioned drawing 7 - 8. Therefore, conventionally, the graphic display and explanation about structure and an equivalent portion are omitted, and are hereafter explained focusing on the characterizing portion of this invention.

[0031]The end (right end of drawing 1) of the transmitting rods 39 and 39 is connected with the end part (left edge part of drawing 1) of one pair of said trunnions 6 and 6, respectively, enabling free rocking. That is, it is made to fit into the crevices 41 and 41 formed in the outer edge surface of the pivots 5 and 5 which formed the spherical bulged parts 40 and 40 in the end of these each transmitting rods 39 and 39, and formed each bulged parts 40 and 40 in said trunnions 6 and 6, respectively, and the swivel joints 42 and 42 are constituted. These each swivel joints 42 and 42 enlarge [enough] fitting strength of said each bulged part 40 and the crevice 41 that sufficient intensity should be held also to the power of not only the power of a compression direction but the direction of hauling.

[0032]The other end (left end of drawing 1) of one pair of said transmitting rods 39 and 39 is connected at the tip of the driving rods 36 and 36 of the oil hydraulic cylinders 38 and 38 which are actuators via the link arms 43 and 43, respectively. These one pairs of link arms 43 and 43 are formed in L type, respectively, and are arranged mutually at axial symmetry. And the other end of each of said transmitting rods 39 and 39 is supported pivotably in the pars intermedia of the one sides 44 and 44 of each of said link arms 43 and 43, and the tip of each of said driving rods 36 and 36 is supported pivotably in the pars intermedia of the other sides 45 and 45 of each of said link arms 43 and 43. Said each link arms 43 and 43 support each pars intermedia pivotably with the axes 46 and 46 into the portion of immobilization in the casing which dedicated the toroidal type nonstep variable speed gear, enabling free rocking. These link arm 43 and the swivel joint 42 make a displacement means of communication.

[0033]Therefore, in connection with the feeding and discarding of the pressure oil to the pressure chambers 47 and 47 of each of said oil hydraulic cylinders 38 and 38, said one pair of trunnions 6 and 6 are displaced to the shaft orientations (longitudinal direction of drawing 1) of the pivots 5 and 5. The pressure chambers 47 and 47 of these each oil hydraulic cylinders 38 and 38 are formed in the side which resists thrust loading added in the arrow alpha and the direction of beta of drawing 1, and displaces said each trunnions 6 and 6 by the 1 side of the driving pistons 37 and 37 in connection with sending of the pressure oil into these pressure chambers 47 and 47. These each thrust loading is added via the power rollers 8 and 8 from an input side, an output side, and both the disks 2 and 4 (drawing 5 -7) at the time of operation of a toroidal type nonstep variable speed gear.

[0034]If the quantity of the pressure oil which is sent in in said one pair of pressure chambers 47 and 47 of the oil hydraulic

cylinders 38 and 38 according to the toroidal type nonstep variable speed gear of this invention constituted as mentioned above is adjusted, Said one pair of trunnions 6 and 6 can be displaced in the direction about the hand of cut of said input side, an output side, and both the disks 2 and 4 (drawing 5 -7). For example, if quantity of the pressure oil sent in in said each pressure chamber 47 and 47 is increased, said each driving pistons 37 and 37 will be displaced up by drawing 1. As a result, said one pair of link arms 43 and 43 with which the tip part of each of said driving rods 36 and 36 was connected rock to the clockwise rotation of drawing 1. And said one pair of trunnions 6 and 6 resist thrust loading of said arrow alpha and the direction of beta, and are displaced to shaft orientations. That is, the trunnion 6 of the drawing 1 upper part is the same with the left of drawing 1, and the lower trunnion 6 is displaced to the right direction, respectively.

[0035]If quantity of the pressure oil sent in in said each pressure chamber 47 and 47 is lessened on the contrary, as for the trunnion 6 of the drawing 1 upper part, the lower trunnion 6 will be displaced to the left according to thrust loading of the direction of arrow beta as well as the right direction of drawing 1 by thrust loading of the direction of arrow alpha, respectively.

[0036]Thus, said one pair of trunnions 6 and 6 are displaced in the circumferencial direction said direction by changing the quantity of the pressure oil sent in in said each pressure chamber 47 and 47. As a result, with change of the direction of the power in which it is added to each tangential direction as mentioned above, the power rollers 8 and 8 supported pivotably by these each trunnions 6 and 6 carry out oscillation displacement, as shown in said drawing 5 - 6, and the change gear ratio between the input side disk 2 and the output side disc 4 is changed.

[0037]Next, drawing 2 shows the second example of this invention. This example applies this invention conventionally which was shown in above-mentioned drawing 8 to structure, i.e., the structure which formed the three power rollers 8 and 8 between the input side disk 2 and the output side disc 4 (drawing 5 - seven references).

[0038]In the case of this example, the tip part of the driving rod 36 of attachment in the first oil hydraulic cylinder 38a that is an actuator is directly connected with the outer edge surface of the pivot 5 fixed to the end of the first trunnion 6a. The end of the transmitting rod 39 is connected with the outer edge surface of the pivot 5 fixed to the end of the second trunnion 6b. And the bending angle has connected the other end of this transmitting rod 39, and the tip part of the driving rod 36 of attachment in the

second oil hydraulic cylinder 38b that is an actuator with the link arm 43a which is 120 degrees. The end of the transmitting rod 39 is connected with the outer edge surface of the pivot 5 fixed to the end of the third trunnion 6c. And the bending angle has connected the other end of this transmitting rod 39, and the tip part of the driving rod 36 of attachment in the third oil hydraulic cylinder 38c that is an actuator with the link arm 43b which is 60 degrees.

[0039]Also when the three power rollers 8 and 8 are formed like this example, the direction alpha and beta, i.e., the arrows of drawing 2, and thrust loading of the direction of gamma are added to the first - the third trunnion 6a-6c about said hand of cut via these each power rollers 8 and 8 at the time of operation of a toroidal type nonstep variable speed gear. By the case where the change gear ratio of a toroidal type nonstep variable speed gear is changed, when quantity of the pressure oil first sent in in the pressure chamber 47 and 47 of said first - the third oil hydraulic cylinder 38a-38c is increased, said first - the third trunnion 6a-6c resist thrust loading of the aforementioned alpha, beta, and the direction of gamma, and are displaced to shaft orientations. If quantity of the pressure oil sent in in the pressure chamber 47 and 47 of each of said oil hydraulic cylinders 38a-38c is lessened on the contrary, said each trunnions 6a-6c will be displaced in these [alpha and beta] and the direction of gamma according to thrust loading of the aforementioned alpha, beta, and the direction of gamma.

[0040]Thus, said first - the third trunnion 6a-6c are displaced in the circumferencial direction said direction by changing the quantity of the pressure oil sent in in said each pressure chamber 47 and 47. As a result, with change of the direction of the power in which it is added to each tangential direction as mentioned above, the power rollers 8 and 8 supported pivotably by these each trunnions 6a-6c carry out oscillation displacement, as shown in said drawing 5 - 6, and the change gear ratio between the input side disk 2 and the output side disc 4 is changed.

[0041]Next, drawing 3 shows the third example of this invention. This example improves the second example mentioned above. In the case of the second example mentioned above, distance L_{39} from the center of the axis 46 which is the center of oscillation of the link arm 43a of attachment in the second trunnion 6b to the other end of the transmitting rod 39 is smaller than distance L_{36} from this center to the tip of the driving rod 36. Therefore, this link arm 43a functions as a lever with an energizing operation. Therefore, if oil pressure sent into said second oil hydraulic cylinder 38b is made the same as the oil pressure sent into the

third oil hydraulic cylinder 38a and 38c for a start, the amount of displacement of said second trunnion 6b will increase more than the amount of displacement of the third trunnion 6a and 6c for a start.

[0042]Therefore, to carry out said second example, it is necessary to make lower than the oil pressure introduced into the third oil hydraulic cylinder 38a and 38c for a start by pressure regulation means, such as a reducing valve, oil pressure introduced in the second oil hydraulic cylinder 38b. Of course, if said distance L_{39} and L_{36} are mutually made equal, such consideration becomes unnecessary, but these both distance L_{39} and L_{36} may not necessarily be able to be mutually made equal for efficiency arrangement of each oil hydraulic cylinders 38a, 38b, and 38c. Then, it is carrying out as [acquire / for a start / said / the structure which can make equal the amount of displacement of the second and third trunnion 6a, 6b, and 6c], without in the case of this example, requiring said pressure regulation means, even if these both distance L_{39} and L_{36} are different.

[0043]That is, in the case of this example, it is a cross-section area (projected net area of the driving piston 37.) of the second oil hydraulic cylinder 38b. It is below the same. S_{38b} is made smaller ($S_{38b}<S_{38a}=S_{38c}$) than cross-section area S_{38a} of the second oil hydraulic cylinder 38a and 38c, and S_{38c} for a start. Thus, the grade for which cross-section area S_{38b} of the second oil hydraulic cylinder 38b is made smaller than cross-section area S_{38a} of the second oil hydraulic cylinder 38a and 38c, and S_{38c} for a start, When it sets according to the difference of said distance L_{39} and L_{36} and the same oil pressure as the pressure chambers 47 and 47 of each oil hydraulic cylinders 38a-38c is introduced, it is made for the power of the shaft orientations of the same size to be added to all the second and third trunnion 6a, 6b, and 6c for a start [said].

[0044]This point is explained in more detail. Direct continuation of the tip of the driving rod 36 of attachment in the first oil hydraulic cylinder 38a is carried out to the first trunnion 6a, The size of the power in which the driving piston 37 of the first oil hydraulic cylinder 38a pushes the driving rod 36 with oil pressure introduction into the pressure chamber 47, and the size of the power applied to the first trunnion 6a are equal. Distance L_{39}' to the other end of the transmitting rod 39 is mutually equal to the third trunnion 6c as well as distance L_{36}' from the center of the axis 46 which supports the attached link arm 43b pivotably to driving rod 36 tip ($L_{36}'=L_{39}'$). Therefore, the size of the power in which the driving piston 37 of the third oil hydraulic cylinder 38c pushes the driving rod 36 with oil pressure introduction into

the pressure chamber 47, and the size of the power applied to the third trunnion 6c are equal. Therefore, cross-section area S_{38a} of the first oil hydraulic cylinder 38a and cross-section area S_{38c} of the second oil hydraulic cylinder 38c are mutually made equal.

[0045]On the other hand, compared with the size of the power of pushing the attached driving rod 36 on said second oil hydraulic cylinder 38b, only the part [size / of the power applied to the second trunnion 6b] according to the ratio (L_{36}/L_{39}) of said both distance L_{39} and L_{36} becomes large. Then, cross-section area S_{38b} of said second oil hydraulic cylinder 38b is made small according to the above-mentioned ratio. That is, in the case of this example, the relation of cross-section area S_{38a} of the second and third oil hydraulic cylinder 38a, 38b, and 38c, S_{38b}, and S_{38c} is regulated as follows for a start.

$S_{38a}=S_{38c}=L_{39}-S_{38b}/L_{36}$[0046]The amount of displacement of the second and third trunnion 6a, 6b, and 6c can be made equal for a start [said], without taking said pressure regulation means to regulate cross-section area S_{38a} of each oil hydraulic cylinders 38a, 38b, and 38c, S_{38b}, and S_{38c} to this appearance. Of course, when distance L_{36}' about said third trunnion 6c differs from L_{39}', cross-section area S_{38c} of said third oil hydraulic cylinder 38c is also changed according to this. Other composition and operations are the same as that of the second example mentioned above.

[0047]Next, drawing 4 shows the fourth example of this invention. As opposed to the first - the third example which were mentioned above having used the swivel joints 42 and 42 (drawing 1 - three references), in order to connect the end of the trunnions 6, 6b, and 6c, and the end of the transmitting rods 39 and 39, In the case of this example, the end of the trunnion 6c and the end of the transmitting rod 39 are connected with the deep groove type ball bearing 48. That is, inner fitting of the outer ring of spiral wound gasket 49 of said ball bearing 48 is carried out to the concave hole 50 of said trunnion 6c end face, and inner fitting of the tip part (top right corner part of drawing 4) of said transmitting rod 39 is carried out to the inner ring 51 of said ball bearing 48. The idle movement axis 52 is fixed to the other end (lower left end of drawing 4) of said transmitting rod 39, and it is made to **** to the long hole 54 in which this idle movement axis 52 was formed to the one side 53 of the link arm 43b. The idle movement axis 55 fixed to the tip part of the driving rod 36 is made to **** to the long hole 57 formed in the other sides 56 of said link arm 43b.

[0048]Transfer of power is enabled between said driving rod 36 and the trunnion 6c, permitting that the trunnion 6c rocks focusing on the pivot 5 with constituting in this appearance.

[0049]
[Effect of the Invention]Although the toroidal type nonstep variable speed gear of this invention is constituted as it was stated above, and it acts, it increases the flexibility of the installed position of an actuator and can attain small size and a weight saving. When an oil hydraulic cylinder is used as an actuator, simplification of the assembly operation by simplification of a hydraulic line can also be attained. As a result, it is small and lightweight, installing in the limited space is easy, and, moreover, a cheap toroidal type nonstep variable speed gear can be provided.

[Brief Description of the Drawings]
[Drawing 1]The partial cutting front view in which showing the first example of this invention and which took out only the important section and was seen from drawing 7 and the direction.
[Drawing 2]The same figure as drawing 1 showing the second example.
[Drawing 3]The same figure as drawing 1 showing the third example.
[Drawing 4]The figure equivalent to the A section of drawing 3 which shows the fourth example.
[Drawing 5]The side view showing the fundamental composition of the toroidal type nonstep variable speed gear known as a conventional art in the state at the time of maximum deceleration.
[Drawing 6]The side view similar to Drawing 5 shown in the state at the time of the maximum accelerating.
[Drawing 7]The sectional view showing one example of the conventional concrete structure.
[Drawing 8]The B-B sectional view of drawing 7.
[Drawing 9]The important section front view showing example of another of conventional structure where a part is cut.
[Description of Notations]
1 Input shaft
2 Input side disk (the first disk)
2a Medial surface
3 Output shaft
4 Output side disc (the second disk)
4a Medial surface
5 Pivot
6 Trunnion
6a The first trunnion
6b The second trunnion
6c The third trunnion
7 Displacement shaft
8 Power roller

8a Peripheral surface
9 Pressing device
10 Cam board
11 Cam roller retaining Cage
12 Cam Roller
13, 14 cam surfaces
15 Input shaft
16 Needle bearing
17 Flange
18 Output-tooth vehicle
19 Key
20 Support plate
21 Supporting spindle part
22 Supporting shaft part
23 Circular hole
24, 25 radial needle bearings
26 Thrust ball bearing
27 Thrust needle bearing
28 Cage
29 Ball
30 Outer ring of spiral wound gasket
31 Race
32 Cage
33 Needle
36 Driving rod
37 Driving piston
38 Oil hydraulic cylinder
38a The first oil hydraulic cylinder
38b The second oil hydraulic cylinder
38c The third oil hydraulic cylinder
39 Transmitting rod
40 Bulged part
41 Crevice
42 Swivel joint
43, 43a, and 43b Link arm
44 One side
45 Other sides
46 Axis
47 Pressure chamber
48 Ball bearing
49 Outer ring of spiral wound gasket
50 Concave hole
51 Inner ring of spiral wound gasket
52 Idle movement axis
53 One side

54 Long hole
55 Idle movement axis
56 Other sides
57 Long hole
58 Frame
59 Holding piece
60 Sleeve
61 Spool
62 Control valve
63 Pump
64 Controlling motor
65 Sump
66 Cam
67 Link
68 Ring part

[Translation done.]